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INSECTICIDAL TESTS OF SOME MATERIALS ON THE MEXICAN BEAN BEETLE

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The Mexican bean beetle (Epilachna varivestis Muls.) has been used as a test insect to determine whether materials found toxic to other insects were toxic to this species. The materials include a large number of synthetic organic compounds, various formulations containing DDT, nicotine preparations, and plant materials. The tests were made when insects and bean foliage were available in the field.

Technique

The spray-tower technique 1/ was used in making these tests. In some of the tests adult beetles were used, but in most of them late third-instar or early fourth-instar larvae were the test insects. Observations were made on feeding, but since in most cases moderate or heavy feeding was accompanied by low mortality no record of the feeding is included in this report. In most instances 4 tests with 10 insects each were made on each material. Acacia (gum arabic) at 1:1000 was used as the wetting agent in most of the sprays. Mortality counts were generally made at the end of 6 days. After the insects had been in a cage with a treated leaf for 3 days, the leaf was removed and an untreated leaf was put in its place. This gave an opportunity for insects that had been slightly poisoned but not killed by the treatment to recover on the untreated foliage. This change of foliage to some degree simulated conditions in the field, where a few days after treatment insects can usually find untreated bean foliage upon which to feed. Foliage-injury tests were made on potted bean plants in the greenhouse.

1/ McGovran, E. R., and Mayer, E. L. A laboratory apparatus and procedure for testing aqueous spray suspensions as insecticides. U.S. Bur. Ent. and Plant Quar. ET-208, 7 pp. 1943. [Processed.]

Derris Standard

Since derris, when available, is widely used for the control of the Mexican bean beetle, it was chosen as a basis for evaluating the various materials. Two samples of derris were used, one containing 4.9 percent of rotenone and the other 4.8 percent. The first sample was used on adults and the second on larvae. When derris was used at the rate of 1 pound per 100 gallons, the average kill of adults was 91 percent and of larvae from 34 to 62 percent (table 2). In tests on larvae with 4 pounds of derris per 100 gallons the kill was somewhat higher but usually not 100 percent. Many adults and larvae that had not fed appreciably on treated foliage, and appeared torpid at the end of 3 days, revived and fed extensively on the untreated foliage when it was put in the cage.

Synthetic Materials 2/

The results with the more toxic synthetic organic compounds tested are given in table 1. Of these, acetone semicarbazone and 4,6-dinitro-o-cresyl acetate were the most toxic. p-aminoacetanilide, cyclohexanone semicarbazone, dinitro-o-cresyl methyl ether, and ethyl methyl ketone semicarbazone also showed high toxicity. All these compounds except p-aminoacetanilide caused foliage injury.

2/ Most of the synthetic materials tested were furnished by the Division of Insecticide Investigations.

Table 1.—Synthetic materials showing considerable insecticidal action on the Mexican bean beetle

Material 1/	Stage of insect	Concentration	Mortality 2/
		Percent	Percent
Acetone semicarbazone	A	1	85 (m-se)
		.5	85
		.25	80
		.125	46
Acetone semicarbazone 50, lime 50	L-4	1	100*(t-sl)
p-Aminoacetanilide	A	.125	7
		.25	58
		.5	78 (n)
		1	91
m-Aminoacetanilide hydrochloride	A	1	78
p-Aminoazobenzene hydrochloride	A	.5	65
		1	69
p-Bromo-N-ethylbenzenesulfonamide	L-4	1	52*
N-Butyl-m-nitrobenzamide	L-3	1	35*
N-sec-Butyl-m-nitrobenzamide	L-3	1	40*
2-(p-Chlorophenyl)-2-phenyl-1,1,1-trichloroethane	L-3	1	57*
Cyclohexanone semicarbazone	L-4	.5	85*
		1	91*(sl-se)
Cyclopentanone semicarbazone	L-4	.5	49*
		1	60*
alpha,beta-Dibromo-beta-nitroethylbenzene	L-4	1	46*

Table 1.--(Continued)

Material 1/	Stage of insect	Concentration	Mortality 2/
		Percent	Percent
N,N-Diethylcinnamide	L-4	1	60*
4,6-Dinitro-o-cresyl acetate	A	.125 .25 .5 1	80 (sl) 94 88 92
4,6-Dinitro-o-cresyl ethyl ether	L-3	1	57*
Dinitro-o-cresyl methyl ether	A	.25 1	55 93 (sl-m)
Diphenylene oxide	A	1	51
Diphenylene oxide 50, magnesium carbonate 50	A	1	66
Diphenylene oxide 20, stearic acid 20, talc 60	A	1	69
Diphenylene oxide 50, zinc stearate 50	A	1	52
Diphenylene oxide 50, talc 50	A	1 2	33 90
N,N-Dipropyl-m-nitrobenzamide	L-3	1	65*
gamma,gamma-Dipyridyl	A	1	72*
Ethyl methyl ketone semicarbazone	L-4	.5 1	95* 85* (se)
2-Furaldehyde semicarbazone	L-4	1	55*

Table 1.—(Continued)

Material 1/	Stage of insect	Concentration	Mortality 2/
		Percent	Percent
Isovaleryl-1,3-indandione	L	1	85*
Pentachlorodihydroxytriphenyl-methane sulfonic acid	A	1	81
Phenazine	A	1 2	81* 71*
Phenothiazine	A	1	94
Phenoxathiin	A	1	61*
p-Phenylazoaniline	A	.125 .25 1	0 14 78
p-Phenylenediamine	A	.125 .25 1	13 32 67
p-Phenylenediamine dihydrochloride	A	1	74
beta-Tetrahydronaphthoylaceto-nitrile 50, pyrophyllite 50	L-4	2	55*
1-Trichloro-2-2 bis(p-methoxy-phenyl)ethane	L	1	65*
2,4-(Trichloromethyl)-sym-trioxane	L-3	1	47*
2-Thiocoumarin	A	.125 .25	7 51
Xanthydrol	A	.125 .25 1	13 20 68

Table 1.--(Concluded)

Material 1/	Stage of Insect	Concentration	Mortality 2/
		Percent	Percent
Derris (rotenone 4.9)	A	.125	91*
Derris (rotenone 4.8)	L-3 and L-4	.125	46* (1942) 62* (1943) 34* (1944)

1/ Numbers in this column refer to percents.

2/ Starred items indicate 6-day mortality, unstarred items 3-day mortality. Letters in parentheses indicate foliage injury as follows: n, none; t, trace; sl, slight; m, moderate; se, severe.

The following synthetic materials showed some toxicity when used at eight times the concentration of derris, but never more than equaled the derris standard in kill:

1-Benzoylthiourea
p-Bromo-N,N-dimethylbenzenesulfonamide
p-Bromo-N-isobutylbenzenesulfonamide
p-Bromo-N-propylbenzenesulfonamide
d-Camphor oxime
p-Chloro-N-propylbenzenesulfonamide
Diazoaminobenzene
2,4-Dimethyl-3-pentanone semicarbazone
4,6-Dinitro-o-cresyl laurate
4,6-Dinitro-o-cresyl myristate
4,6-Dinitro-o-cresyl propionate
2,4-Dinitrophenyl propionate
Disodium ethylenebisdithiocarbamate
Ethylidenebisbenzamide
2-Furanacrylamide

alpha,alpha,alpha,alpha',alpha',alpha'-Hexachloro-p-xylene
2'-Hydroxy-2,4,4,4',7-pentamethylflavan
N-Isobutyl-m-nitrobenzamide
5-(p-Methoxybenzylidene)-2-thio-4-thiazolidone
p-Nitroacetanilide
4-Phenylthiosemicarbazide
o-Phthalonitrile
4,4',4''-Triaminotriphenylcarbinol (p-rosaniline base)
alpha,alpha,beta-Trichlorobutyramide
Veratrine
Xanthene

The following synthetic materials showed little if any toxicity to the Mexican bean beetle when tested at a strength of 1 percent:

Materials Tested as Sprays	Materials Tested as Dusts
5-Benzylidene-2-thio-4-thiazolidone	N-Acetyl-alpha-naphthylamine
2-Chlorofluorene	N-Acetyl-beta-naphthylamine
p,p'-Dichlorophenyl sulfone	Allylthiourea
Diisophorone	3-Anilinophenothiazine
1,4-Dinitrosopiperazine	Azobenzene
1,4-Diphenylsemicarbazide	Azoxybenzene
2-Fluorylamine	Benzalazine
alpha,alpha,alpha,alpha',alpha', alpha'-Hexachloro-o-xylene	2-Chloroacridone
4-(p-Methyl-alpha-thiotoluyl)-morpholine	Copper sulfoleoarsenite
N-Methyl-m-nitrobenzamide	Dichloramine-T
Tetrachloroquinone	p,p'-Difluorodiphenyl
4-(alpha-Thiotoluyl)morpholine	Bis(p-dimethylaminophenyl) sulfide
1-Trichloro-2,2-bis(p-bromophenyl)-ethane	4-Hydroxyacridone
	Nitroguanidine
	N-p-Nitrophenylsulfanyl) acetanilide
	Piperonal oxime, "anti" form
	Piperonal oxime, "syn" form

DDT Sprays

The results of tests with various sprays containing DDT (1-trichloro-2,2-bis(p-chlorophenyl)ethane) are given in table 2. When used alone DDT was not highly toxic to Mexican bean beetle larvae. The addition of sulfonated castor oil to the spray greatly increased its toxicity. The mixtures were prepared by dissolving

the DDT in acetone and then adding the sulfonated castor oil. Calcium cyanamide combined with DDT and sulfonated castor oil killed all the larvae, but calcium cyanamide alone caused appreciable mortality.

Table 2.—Toxicity of various sprays containing DDT to the Mexican bean beetle

Formulation	DDT concentration in spray	Mortality in 6 days
	Percent	Percent
DDT (technical)	1.0	45
DDT 10 percent in pyrophyllite		35
DDT 10 gm., sulfonated castor oil 10 ml., acetone 80 ml.:	.5	
No added ingredient		95
Plus calcium carbonate 5 gm.		95
Plus calcium cyanamide 5 gm.		100
Plus calcium sulfate 5 gm.		95
DDT 5 gm., sulfonated castor oil 10 ml., acetone 85 ml.:	.25	
No added ingredient		65
Plus ammonium chloride 5 gm.		57
Plus ammonium hydroxide 5 ml.		55
Plus ammonium sulfate 5 gm.		70
Calcium cyanamide	1.0 1/	40
Derris standard	0.125 1/	34

1/ Percent of material indicated.

Nicotine Preparations 3/

A number of preparations containing nicotine were tested against Mexican bean beetle larvae. Nicotine refers to the uncombined alkaloid often referred to as free nicotine. Mixtures with nicotine contained 10 gm. of the compound to 4 gm. of nicotine. Of these, o-nitrodiphenyl mixed with nicotine gave the highest mortality. This preparation, when used at about 25 times the concentration of derris (4.8 percent rotenone), caused 88 percent mortality as compared with 34 percent for the derris standard. A 5-percent solution of 40 percent nicotine sulfate was slightly more toxic than 1 pound of derris per 100 gallons of spray. Nicotine was somewhat less effective under the conditions of these tests. The following preparations showed little or no toxicity to the larvae when used at many times the concentration of derris:

Benzyl nicotinium stearate
Butyl carbitol plus nicotine
Butyl ether of ethylene glycol (Butyl Cellosolve) plus nicotine
Cupric mononicotinammino oleate
Cupric nicotinammino hexoate
Cupric nicotinammino compounds of coconut oil fatty acids
p,p-Dichlorodiphenyl sulfide plus nicotine
Dioctyl sodium sulfosuccinate (Aerosol OT) plus nicotine
Ethyl ether of ethylene glycol plus nicotine (Cellosolve)
Glycerol plus 40 percent nicotine sulfate
Methyl carbitol plus nicotine
Molasses plus 40 percent nicotine sulfate
Sodium salt of sulfonated ethyl oleate (Artic Syntex) plus nicotine

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3/ Most of the nicotine preparations tested were supplied by the Eastern Regional Research Laboratory, Bureau of Agricultural and Industrial Chemistry.

Plant Sample

A sample of plant material that was tested, Humulus lupulus, showed only very slight toxicity to Mexican bean beetle larvae.

Summary

Results are given of laboratory tests of the insecticidal action of 94 synthetic organic compounds, 8 DDT and 13 nicotine combinations, and 1 plant material, with the Mexican bean beetle (Epilachna varivestis Muls.) as the test insect. Acetone semicarbazone and 4,6-dinitro-o-cresyl acetate were highly toxic to the insects but caused injury to bean foliage. DDT combined with sulfonated castor oil was more toxic to Mexican bean beetle larvae than DDT alone.